ERDC/CERL TR-01-43

Construction Engineering
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Site Evaluation for Application of Fuel Cell Technology

Kirtland Air Force Base, NM

Michael J. Binder, Franklin H. Holcomb, and
William R. Taylor

April 2001

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Foreword

In fiscal years 93 and 94, Congress provided funds for natural gas utilization equipment, part of which was specifically designated for procurement of natural gas fuel cells for power generation at military installations. The purchase, installation, and ongoing monitoring of 30 fuel cells provided by these appropriations has come to be known as the "DOD Fuel Cell Demonstration Program." Additional funding was provided by: the Office of the Deputy Under Secretary of Defense for Industrial Affairs & Installations, ODUSD (IA&I)/HE&E; the Strategic Environmental Research & Development Program (SERDP); the Assistant Chief of Staff for Installation Management (ACSIM); the U.S. Army Center for Public Works (CPW); the Naval Facilities Engineering Service Center (NFESC); and Headquarters (HQ), Air Force Civil Engineer Support Agency (AFCESA).

This report documents work done at Kirtland Air Force Base (AFB), Albuquerque, NM. Special thanks is owed to the Kirtland AFB point of contact (POC), Steve Klimm, for providing investigators with access to needed information for this work. The work was performed by the Energy Branch (CF-E), of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Michael J. Binder. Part of this work was performed by Science Applications International Corp. (SAIC), under Contract DACA88-94-D-0020, task orders 0002, 0006, 0007, 0010, and 0012. The technical editor was William J. Wolfe, Information Technology Laboratory. Larry M. Windingland is Chief, CEERD-CF-E, and L. Michael Golish is Chief, CEERD-CF. The associated Technical Director was Gary W. Schanche. The Acting Director of CERL is William D. Goran.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

Contents

List of Figures and Tables

Figures

Tables

1 Introduction

Background

Fuel cells generate electricity through an electrochemical process that combines hydrogen and oxygen to generate direct current (DC) electricity. Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Air emissions from fuel cells are so low that several Air Quality Management Districts in the United States have exempted fuel cells from requiring operating permits. Today's natural gas-fueled fuel cell power plants operate at electrical conversion efficiencies of 40 to 50 percent; these efficiencies are predicted to climb to 50 to 60 percent in the near future. In fact, if the heat from the fuel cell process is used in a cogeneration system, efficiencies can exceed 85 percent. By comparison, current conventional coal-based technologies operate at efficiencies of 33 to 35 percent.

Phosphoric Acid Fuel Cells (PAFCs) are in the initial stages of commercialization. While PAFCs are not now economically competitive with other more conventional energy production technologies, current cost projections predict that PAFC systems will become economically competitive within the next few years as market demand increases.

Fuel cell technology has been found suitable for a growing number of applications. The National Aeronautics and Space Administration (NASA) has used fuel cells for many years as the primary power source for space missions and currently uses fuel cells in the Space Shuttle program. Private corporations have recently been working on various approaches for developing fuel cells for stationary applications in the utility, industrial, and commercial markets. Researchers at the U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93), and have successfully executed several research and demonstration work units with a total funding of approximately $55M.

As of November 1997, 30 commercially available fuel cell power plants and their thermal interfaces have been installed at DoD locations, CERL managed 29 of these installations. As a consequence, the Department of Defense (DoD) is the

owner of the largest fleet of fuel cells worldwide. CERL researchers have developed a methodology for selecting and evaluating application sites, have supervised the design and installation of fuel cells, and have actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to manufacturers. This accumulated expertise and experience has enabled CERL to lead in the advancement of fuel cell technology through major efforts such as the DoD Fuel Cell Demonstration Program, the Climate Change Fuel Cell Program, research and development efforts aimed at fuel cell product improvement and cost reduction, and conferences and symposiums dedicated to the advancement of fuel cell technology and commercialization.

This report presents an overview of the information collected at Kirtland Air Force Base (AFB), NM along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the site evaluation surveys for the remaining 28 sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report (see Table 1).

Objective

The objective of this work was to evaluate Kirtland AFB as a potential location for a fuel cell application.

Approach

On 25 and 26 April 1994, Science Applications International Corporation (SAIC) visited Kirtland Air Force Base (the site) to investigate it as a potential location for a 200 kW phosphoric acid fuel cell. This report presents an overview of information collected at the site along with a conceptual fuel cell installation layout and description of potential benefits. The appendix to this report includes a copy of the site evaluation form filled out at the site.

Table 1. Companion ERDC/CERL site evaluation reports.

Location	Report No.
Pine Bluff Arsenal, AR	TR 00-15
Naval Oceanographic Office, John C. Stennis Space Center, MS	TR 01-3
Fort Bliss, TX	TR 01-13
Fort Huachuca, AZ	TR 01-14
Naval Air Station Fallon, NV	TR 01-15
Construction Battalion Center (CBC), Port Hueneme, CA	TR 01-16
Fort Eustis, VA	TR 01-17
Watervliet Arsenal, Albany, NY	TR 01-18
911th Airlift Wing, Pittsburgh, PA	TR 01-19
Westover Air Reserve Base (ARB), MA	TR 01-20
Naval Education Training Center, Newport, RI	TR 01-21
U.S. Naval Academy, Annapolis, MD	TR 01-22
Davis-Monthan AFB, AZ	TR 01-23
Picatinny Arsenal, NJ	TR 01-24
U.S. Military Academy, West Point, NY	TR 01-28
Barksdale Air Force Base (AFB), LA	TR 01-29
Naval Hospital, Naval Air Station Jacksonville, FL	TR 01-30
Nellis AFB, NV	TR 01-31
Naval Hospital, Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, CA	TR 01-32
National Defense Center for Environmental Excellence (NDCEE), Johnstown, PA	TR 01-33
934th Airlift Wing, Minneapolis, MN	TR 01-38
Laughlin AFB, TX	TR 01-41
Fort Richardson, AK	TR 01-42
Kirtland AFB, NM	TR 01-43
Subase New London, Groton, CT	TR 01-44
Edwards AFB, CA	TR 01-Draft
Little Rock AFB, AR	TR 01-Draft
Naval Hospital, Marine Corps Base Camp Pendleton, CA	TR 01-Draft
U.S. Army Soldier Systems Center, Natick, MA	TR 01-Draft

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

1 ft	=	0.305 m
1 mile	=	1.61 km
1 acre	=	0.405 ha
1 gal	=	3.78 L
°F	=	°C (X 1.8) + 32

2 Site Description

Kirtland AFB is located in Albuquerque, NM directly adjacent to the commercial airport. Sandia National Labs is located on the base. The Site consists of a wide range of buildings including office buildings, central plants, airplane hangers, etc. Temperatures range from the teens in the winter to over 100 °F in the summer.

The western side of the base is supplied heating and steam by a central heating plant. This was the only site that was considered for a 200 kW fuel cell.

The central plant is a 4,800 sq ft (48 x 100-ft) building. Although it is technically a one story building, it is approximately three stories tall. The site consists of four boilers (420 to 440 hp) with between one and three boilers operating 24 hours per day, every day. No electric consumption data on the building was available, but is estimated to be less than 100 kW. Site make-up water requirements were provided and averaged about 400 gal per hour throughout the year.

Site Layout

Figure 1 shows the site layout for the central plant facility. The building consists of a single large room containing the four boilers, pumps, water softeners, electrical switch gear and assorted equipment. An office is located in the southeast corner of the building. Up a ladder stairway near the roof is a deaerator and a 1,500 gal storage tank, which is used to feed the boilers. Both the city make-up water and condensate return are fed into the deaerator.

Electrical System

The central plant is supplied by three 4160/480 volt transformer (37.5 kVA), which are located on the south side of the building. The electrical switch gear is located in the boiler plant. There is also a small 480/120-208 volt transformer located next to the switch gear boxes. Kirtland AFB is currently upgrading its electrical distribution system on the base to 12,480 volts. The central plant electric transformer is not expected to be upgraded for 3 years, but this could be expedited if the Site is selected for a 200 kW fuel cell.

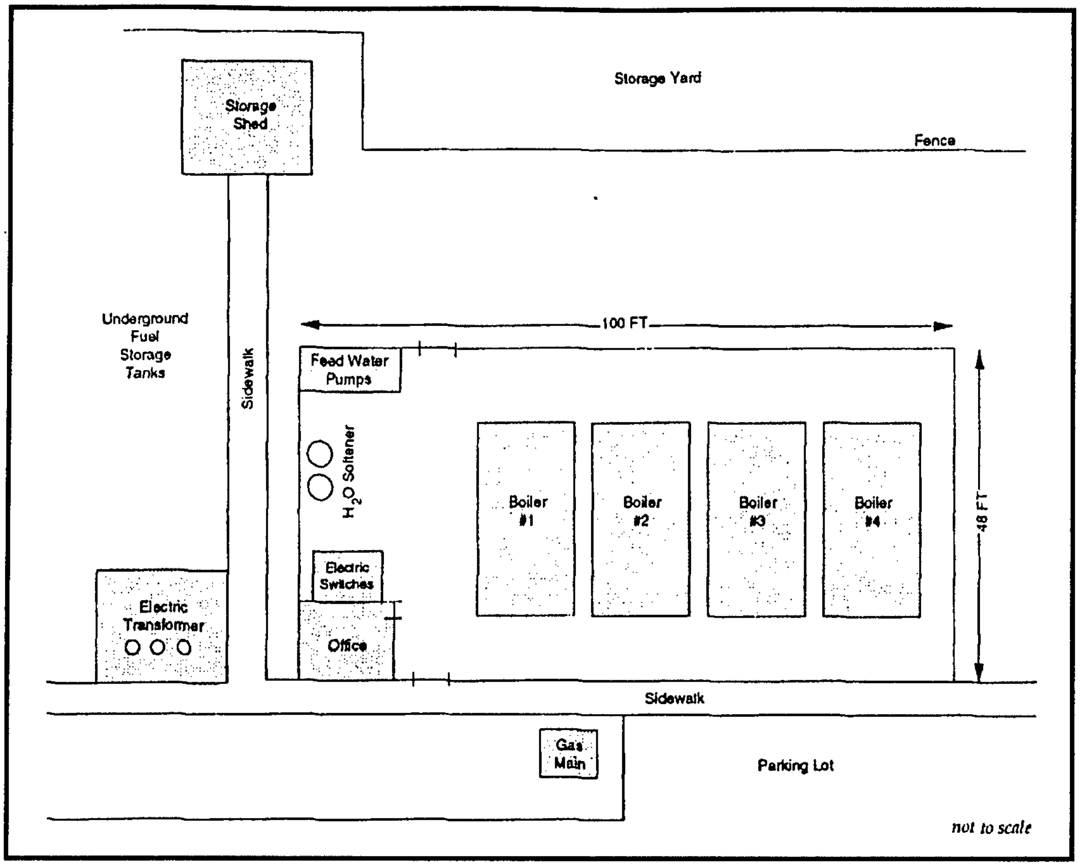

Figure 1. Kirtland AFB Central Heating Plant layout.

Steam/Hot Water System

The central plant has two 440 HP Wickes Boiler Co. boilers and two 420 hp Erie Co. boilers. During the winter, 2-3 boilers operate while in the summer, 1-2 boilers operate. The heating season at Kirtland AFB is usually October – April.

City water is fed into two Culligan water softeners and then fed up to a deaerating heater. Water is then fed into a storage tank, which feeds into the boiler on an as needed basis. Output from the steam boiler is about 385 °F at 125 psig. Return condensate temperatures are approximately 180 °F. Figure 2 shows the flow diagram for the boiler input.

Space Heating System

Steam is sent out to various locations on the west side of Kirtland AFB. Hydronic systems are located in individual buildings.

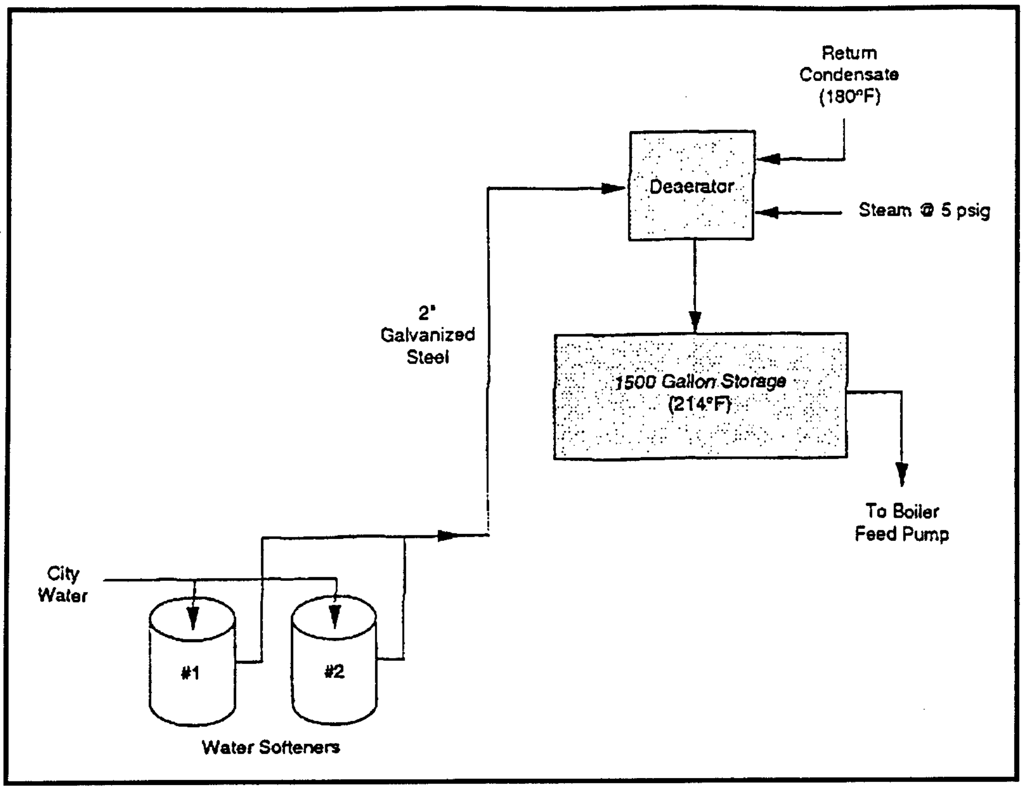

Figure 2. Boiler feed water process diagram.

Space Cooling System

A small window air conditioner is used for cooling the central plant office area. The steam system does not drive any absorption chillers.

Fuel Cell Location

Behind the central plant facility (west side) is an equipment storage yard. Site personnel recommended this location for the 200 kW fuel cell. On the south side next to the transformer is an open area, but is not viable because of two 33,000 gal fuel storage tanks buried underground. To accommodate the fuel cell, the fence around the equipment yard would have to be moved. Site personnel did not expect any problem in moving the fence.

Figure 3 shows the location of the proposed fuel cell site along with proposed thermal and electric runs. The thermal piping run will be approximately 70 ft into the building. The electric connection at the present site of the transformer will be about 90 ft from the fuel cell. The natural gas will have to be run from the front of the building, around the side and back to the fuel cell (about 140 ft).

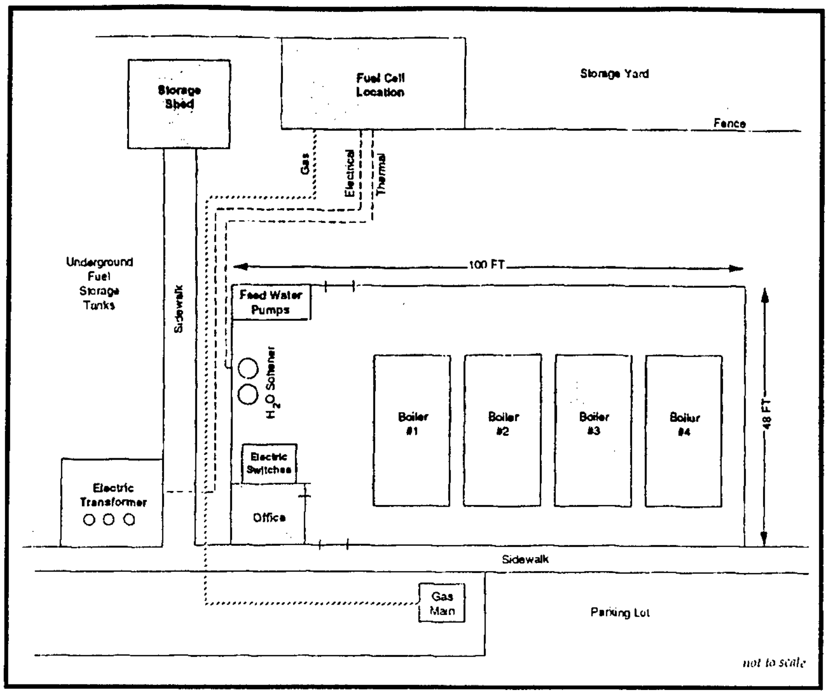

Figure 3. Kirtland AFB Central Heating Plant site layout and fuel cell location.

Fuel Cell Interfaces

Electric power is supplied to the central heating plant through three 4160/480 volt single phase 37.5 kVA transformers. The electricity consumption of the plant is not separately metered. The electric loads consist of four 20 hp boiler feed water pumps, two 10 hp fan motors, one 7.5 hp air compressor, one 2 hp oil pump and lighting loads. This load is estimated to be no more than 100 kW. Therefore, most of the fuel cell electric output will be fed back into the base grid to maintain a high electric capacity factor for the fuel cell. The existing three 37.5 kVA transformers do not have the capacity to handle the 235 kVA fuel cell output. The three single phase transformers should be replaced by a three phase 4160/480 volt, 250 kVA or higher transformer. The fuel cell should be electrically connected to the 480 volt side of the new transformer.

The only fuel cell thermal interface is to preheat the boiler make-up water. The total make-up water used in 1989 (typical year) was 3.57 million gal, see Table 2. The make-up water is required for losses in the district heating system and for live steam used in the kitchens. The make-up water use is seasonal, averaging 525 gal per hour during the heating season (October - April) and 246 gal per hour during the non-heating season (May - September). Figure 4 shows the fuel cell thermal interface diagram.

Table 2. Boiler operating data and energy values.

1	2	3	4	5	6
Date	Days in Month	Boiler Op. Hours	Make-up Water (Gal)	Make-up Gal/Hour	Make-up Btu/Hour
Jan 93	31	744	488,480	657	630,885
Feb 93	28	672	366,860	546	524,575
Mar 93	31	744	388,900	523	502,275
Apr 93	30	720	450,610	626	601,374
May 93	31	744	209,410	281	270,459
Jun 93	30	720	154,260	214	205,872
Jul 93	31	744	233,880	314	302,062
Aug 93	31	744	162,620	219	210,028
Sep 93	30	720	145,440	202	194,101
Oct 93	31	744	238,830	321	308,455
Nov 93	30	720	367,850	511	490,924
Dec 93	31	744	366,562	493	473,425
Tot/Avg	334	8760	3,573,702	408	392,004

Col. 4 = from boiler log sheet
Col. 5 = #4/#3
Col. 6 = #5 * 8.35 lbs/Gal * (175-60 deg F)
* Boiler operation could be from 1 to 3 boilers throughout period

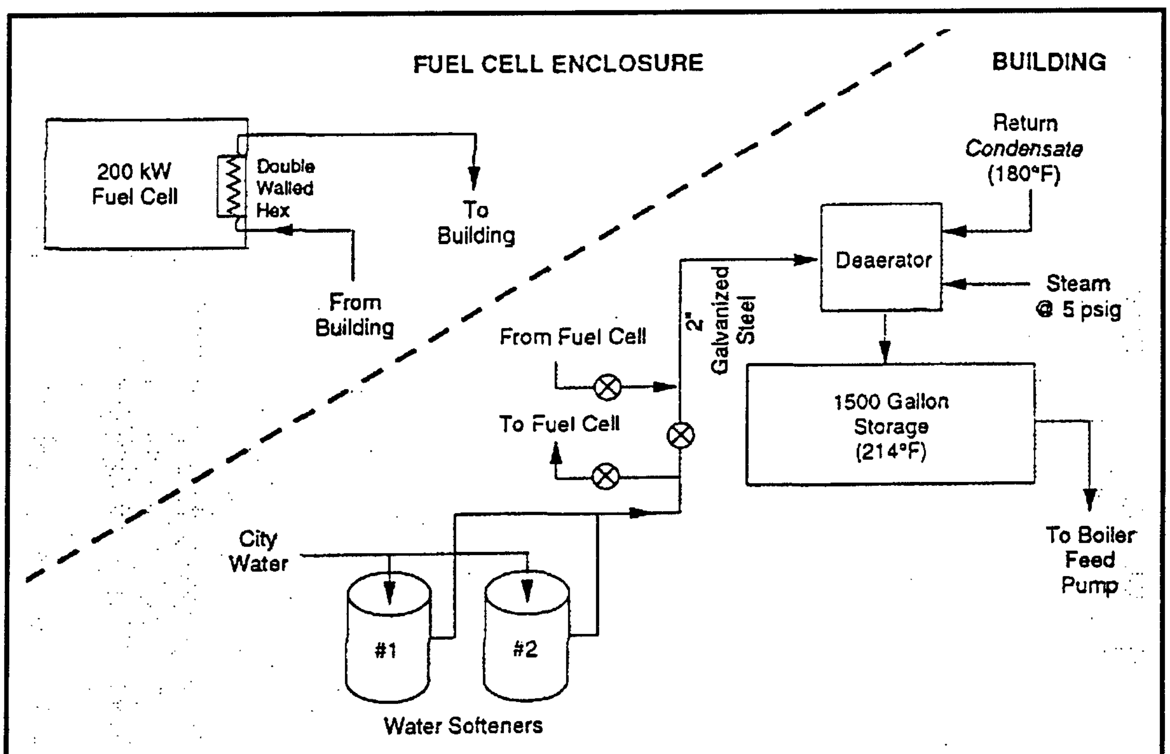

Figure 4. Fuel cell thermal interface.

Assuming a 60 °F city water temperature, the fuel cell will heat the make-up water to about 178 °F and supply about 520 kBtu/hr. During the non-heating season, the fuel cell will heat the water to about 182 °F and supply about 250 kBtu/hr. The average annual fuel cell output used by the site is 392 kBtu/hr (see Table 2) and the annual site utilization will be 3,035 MBtu/year (392 kBtu/hr * 8760 hours/yr * 90 percent) based on a 90 percent fuel cell electric capacity factor. This represents a 56 percent thermal utilization of the fuel cell thermal output (392 kBtu/hr / 700 kBtu/hr).

No hourly water usage data was available for the central heating plant. Because of the diversity of loads supplied by the central heating plant, the hourly loads are not likely to vary widely. To assess whether thermal storage is required, variances from the monthly average water usage were calculated. In the winter, the average flow rate (load) would need to increase by 35 percent (700 - 520 kBtu/hr / 520 kBtu/hr) before thermal storage would be required. In the summer, the average flow rate (load) could increase 2.8 times (700 - 250 kBtu/hr / 250 kBtu/hr) before thermal storage would be required. It is possible that thermal storage would increase the fuel cell thermal utilization during some periods in the winter. Thermal storage would not likely be used during the summer period. Although data is not available, the additional thermal storage required during the winter months only would not likely be sufficient to justify thermal storage cost for this application. Detailed hourly water loads should be obtained (if possible) to verify these assumptions. Figure 5 shows a layout of the fuel cell site area.

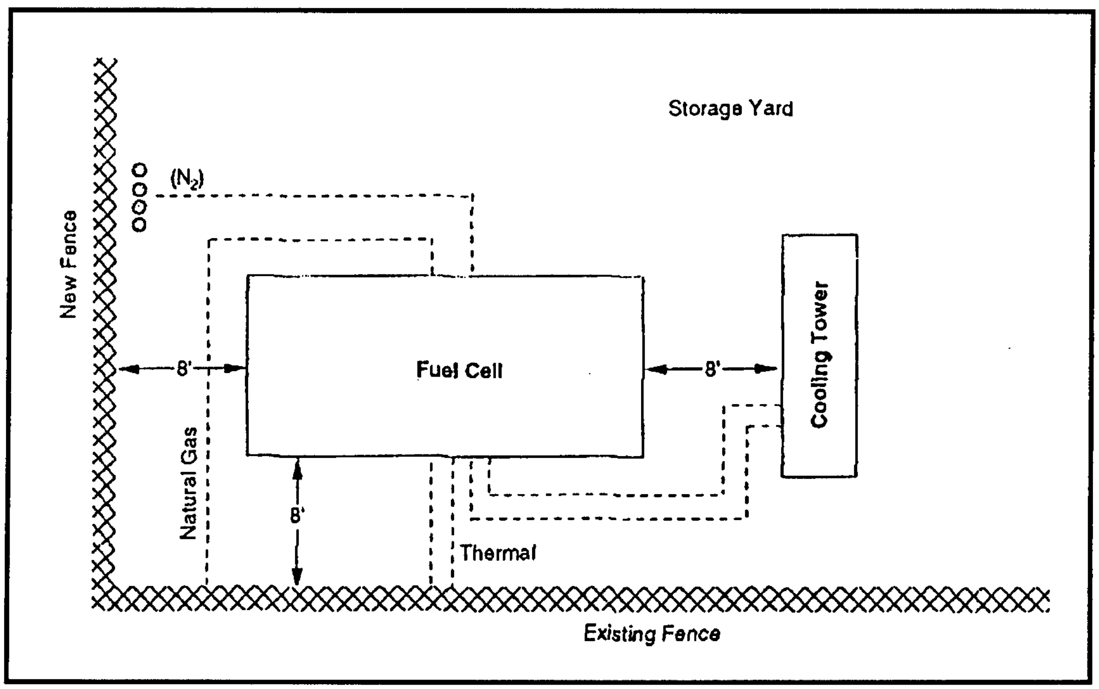

Figure 5. Fuel cell layout.

Economic Analysis

Kirtland AFB is located in Public Service Co. of New Mexico's service territory. Table 3 lists the 1993 electric bills. The average rate ranged from 6.04 cents/kWh (November) to 7.45 cents/kWh (June). The average electric rate paid by the Site in 1993 was 6.6 cents/kWh. The site is billed under rate schedule 4000B, a "time-of-use" rate. The on-peak period is from 8:00 a.m. to 8:00 p.m. Monday–Friday, the whole year. The summer period is June through August. The off-peak period is all remaining hours including weekends and holidays.

The Site is billed for natural gas from the Gas Company of New Mexico, which is supplied by Gulf Gas Utilities under a transportation contract. Table 4 lists the natural gas bills for the base in 1993. Gas costs ranged from $2.30/MBtu (February) to $3.93/MBtu (December); the average rate for the year was $3.09/MBtu.

Table 5 shows the demand and energy electric rates under rate schedule 4000B. This table also presents the first year electric savings from a 200 kW fuel cell based on a 90 percent electric capacity factor, assuming that the fuel cell outage hours during the on/off-peak periods occurred at the same percentages as shown in Table 5. That is, outage hours were not weighted more heavily in either the on-peak or off-peak periods, but were proportional to the number of period hours in a year. Total first year electric savings using a 90 percent electricity capacity factor was $91,960, which includes full demand charge savings. This works out to an average displaced electric rate of 5.83 cents/kWh ($17.08/MBtu), slightly less than the 1991-1992 DEIS database average of 6.35 cents/kWh ($18.59/MBtu).

Table 3. Kirtland Air Force Base electricity consumption.

Date	Peak KW	On-Peak KWH	Off-Peak KWH	Total KWH	Total Bill	$/KWH
Jan 93	48,840	10,185,938	15,234,274	25,420,212	$1,633,586	$0.0643
Feb 93	49,440	9,790,537	13,583,024	23,373,561	$1,432,495	$0.0613
Mar 93	48,984	11,346,981	14,449,419	25,796,400	$1,569,290	$0.0608
Apr 93	50,892	10,720,602	13,565,493	24,286,095	$1,533,524	$0.0631
May 93	54,732	10,492,418	14,839,449	25,331,867	$1,643,699	$0.0649
Jun 93	59,832	12,037,285	15,067,485	27,104,770	$2,020,436	$0.0745
Jul 93	60,012	12,524,391	16,752,159	29,276,550	$2,135,361	$0.0729
Aug 93	58,776	12,352,309	16,306,739	28,659,048	$2,089,901	$0.0729
Sep 93	56,028	11,456,390	14,896,729	26,353,119	$1,771,654	$0.0672
Oct 93	52,740	10,159,614	15,188,002	25,347,616	$1,636,989	$0.0646
Nov 93	49,488	10,492,821	14,557,918	25,050,739	$1,513,739	$0.0604
Dec 93	50,016	10,144,709	14,263,352	24,408,061	$1,510,524	$0.0619
Total/Avg	53,315	131,703,995	178,704,043	310,408,038	$20,491,198	$0.0660

Table 4. Kirtland Air Force Base natural gas consumption.

Date	MBtu	Amount	$/MBtu
Jan 93	188,072	$711,835	$3.78
Feb 93	179,850	$413,814	$2.30
Mar 93	140,965	$367,761	$2.61
Apr 93	122,754	$327,973	$2.67
May 93	78,081	$261,937	$3.35
Jun 93	64,568	$219,338	$3.40
Jul 93	52,718	$150,063	$2.85
Aug 93	48,291	$148,834	$3.08
Sep 93	69,853	$222,412	$3.18
Oct 93	100,819	$259,867	$2.58
Nov 93	163,345	$488,935	$2.99
Dec 93	186,626	$733,990	$3.93
Total/Avg	1,395,942	$4,306,759	$3.09

Table 5. Public Service Co. of New Mexico Rate Schedule 4000B.

	Summer	Winter	
Demand Charge			
On-Peak ($/kW)	$8.70	$8.70	
Energy Charge			
On-Peak ($/kWh)	$0.068524	$0.054744	
Off-Peak ($/kWh)	$0.037826	$0.037826	
Hours/Year			
On-Peak	780	2,340	35.6%
Off-Peak	1,404	4,236	64.4%
	2,184	6,576	
Savings/Year (90% ELF)			
On-Peak Energy	$9,621	$23,058	$32,679
Off-Peak Energy	$9,559	$28,842	$38,401
Total Energy	$19,180	$51,900	$71,080
Demand (200 kW)	$5,220	$15,660	$20,880
Total Savings;	$24,400	$67,560	$91,960
Average $/kWh:	$0.0583		

Based on a thermal utilization of 56 percent and an electric capacity factor of 90 percent, the potential energy savings from a 200 kW fuel cell were calculated. Table 6 lists the electric and thermal savings and input natural gas costs for the central heating plant. For comparison, a 100 percent thermal utilization scenario is presented. The net savings for the 56 percent thermal utilization was $58,499 in the first year. The impact of only achieving 50 percent demand savings and no demand savings is also presented in Table 6.

Table 6. Economic savings of fuel cell design alternatives.

Case	ECF	TU	Displaced kWh	Displaced Gas (MBtu)	Electrical Savings	Thermal Savings	Nat. Gas Cost	Net Savings
A - Max. Thermal	90%	100%	1,576,800	7,357	$91,960	$22,733	$46,192	$68,501
A - Central Plant Base Case	90%	56%	1,576,800	4,120	$91,960	$12,731	$46,192	$58,499
B - Max. Thermal	90%	100%	1,576,800	7,357	$81,520	$22,733	$46,192	$58,061
B - Central Plant Base Case	90%	56%	1,576,800	4,120	$81,520	$12,731	$46,192	$48,059
C - Max. Thermal	90%	100%	1,576,800	7,357	$71,080	$22,733	$46,192	$47,621
C - Central Plant Base Case	90%	56%	1,576,800	4,120	$71,080	$12,731	$46,192	$37,619

Assumptions:

Input natural gas rate:	$3.09 /MBtu
Displaced thermal gas rate:	$3.09 /MBtu
Displaced electricity rate:	4000B
Fuel cell thermal output:	700,000 Btu/hour
Fuel cell electrical efficiency:	36%
Seasonal boiler efficiency:	75%

CASE A: full fuel cell demand savings

CASE B: 50% of full fuel cell demand savings

CASE C: zero fuel cell demand savings

ECF = Fuel cell electric capacity factor

TU = Thermal utilization

The analysis is a general overview of the economics. For the first 5 years, ONSI will be responsible for the fuel cell maintenance. Maintenance costs are not reflected in this analysis, but could represent a significant impact on net energy savings. Since load profile data were not available, energy savings could vary depending on actual electrical and thermal utilization.

3 Conclusions

This study concludes that the Kirtland AFB central heating plant is a good application for a 200 kW fuel cell because the plant operates 24 hours per day, 7 days per week. The thermal interface is relatively straightforward at this site and will not likely require thermal storage. The Site is upgrading electric transformers and this process could be expedited for the central heating plant. A 4160/480 volt transformer of 250 kVA or greater should be installed to use the total electrical output of the fuel cell.

The nearby equipment yard is a good location for the fuel cell. Trenching will be kept to a minimum. The natural gas line will be the longest pipe run to the fuel cell because of its present location.

Appendix: Kirtland AFB Fuel Cell Site Evaluation Form

Site Name: **Kirtland Air Force Base**
Location: **Albuquerque, NM** Contacts: **Steve Klimm**

1. Electric Utility: **Pub. Service Co. of New Mexico** Rate Schedule: **4000B**
   Contact: **Tom Krattiger**

2. Gas Utility: **Gas Co. of New Mexico** Rate Schedule: **Transportation**
   Contact: **Mike D'Antonio**

3. Available Fuels: Natural Gas, Fuel Oil Capacity Rate:

4. Hours of Use and Percent Occupied:
   Weekdays 100% Hrs. 24
   Saturday 100% Hrs. 24
   Sunday 100% Hrs. 24

5. Outdoor Temperature Range: **Teens - 100 °F**

6. Environmental Issues: **Winter can sometimes reach non-attainment levels**

7. Backup Power Need/Requirement: **Several individual systems throughout base**

8. Utility Interconnect/Power Quality Issues: **Power lines and transformers on the base are being upgraded over next 5 years**

9. On-site Personnel Capabilities: **Gas Company will perform fuel cell maintenance**

10. Access for Fuel Cell Installation: **Proposed site is in the middle of a storage yard**

11. Daily Load Profile Availability: **No data available**

12. Security: **Install fence**

Site Layout

Facility Type: **Central Heating Plant** Age: **1951**
Construction: **Concrete block**

Square Feet: **4,800 sq ft (48 X 100 ft)**

See Figure 1

Show:

- **electrical/thermal/gas/water interfaces and length of runs**
- **drainage**
- **building/fuel cell site dimensions**
- **ground obstructions**

Electrical System

Service Rating: **4,160 volt service to building**
480 and 120/208 volt service in building

Electrically Sensitive Equipment: **None**

Largest Motors (hp, usage):

Grid Independent Operation?: **No**

Steam/Hot Water System

Description: **Wickes Boiler Co. (2 - 440 hp); Erie Boiler (2 - 420 hp)**

System Specifications:
Fuel Type: **Natural gas**
Max Fuel Rate:
Storage Capacity/Type:
Interface Pipe Size/Description: **2 in.**

End Use Description/Profile: **Steam from the boiler is used to send out steam for heating, cooking and misc. uses.**

See Figure 2

Space Cooling System

Description: **None**

Air Conditioning Configuration:
- Type:
- Rating:
- Make/Model:

Seasonality Profile:

Space Heating System

Description: **No space heating in facility**

Fuel:

Rating:

Water supply Temp:

Water Return Temp:

Make/Model:

Thermal Storage (space?):

Seasonality Profile: **None available**

Billing Data Summary

ELECTRICITY

Period	kWh	kW	Cost
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10			
11.			
12.			

NATURAL GAS

Period	Consumption	Cost
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10		
11.		
12.		

OTHER

Period	Consumption	Cost
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10		
11.		
12.		

CERL Distribution

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8
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14. ABSTRACT

Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Researchers at the U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93). CERL has selected and evaluated application sites, supervised the design and installation of fuel cells, actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to manufacturers for 29 of 30 commercially available fuel cell power plants and their thermal interfaces installed at Department of Defense (DoD) locations.

This report presents an overview of the information collected at the Kirtland Air Force Base, NM, along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the site evaluation surveys for the remaining 28 sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report.

15. SUBJECT TERMS
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